

The present invention is directed to fluid-tight dynamic clearance seals formed between a moving and a stationary member without a direct contact therebetween and fluid-moving equipment utilizing such seals. Accordingly, independent claim 1 is directed to a clearance seal assembly comprising "a sealing member circumferentially disposed between the stationary member and the moving member, the sealing member having a fluid-tight relationship with the stationary member, wherein the sealing member and the moving member define a continuous and uniform gap, having a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap ... under an operating pressure differential..."

Independent claim 7 is directed to a pump comprising "a sealing member circumferentially disposed between the housing structure and the piston, the sealing member having a fluid-tight relationship with the housing structure, and the sealing member and the piston defining a continuous and uniform gap, wherein the gap has a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap from the suction chamber to an outside of the chamber under an operating fluid pressure."

As explained on page 6, lines 23-30, of the specification, it is an unexpected discovery of the present invention that the size of the gap between a moving and a stationary member may be selected to allow the fluid to fill the gap, thus avoiding a dry friction, but to prevent the fluid from flowing through the gap. It is believed that when the clearance gap is sufficiently small, the adhesive forces of the fluid toward the piston and the seal are greater than the force exerted by the fluid due to an operating pressure, thus preventing the fluid from flowing through the gap (page 6, lines 23-30).

The present inventors also discovered that in order to achieve the desired hydraulic seal between the moving member, such as a piston, and the sealing member, the gap therebetween must be "continuous" and "uniform" (page 6, lines 10-22). For the purposes of the present invention, a "continuous gap" means that the sealing member and the moving member do not have any points of direct contact. A "uniform gap" means that the distance between the moving and the

stationary member does not vary significantly so as to compromise the hydraulic seal formed therebetween. Accordingly, the instant specification teaches that radial dimensions of an outer wall of the moving member and the internal wall of the sealing member and their assembly must be closely controlled (page 6, lines 10-22).

In the present invention, in order to prevent radial deformation and/or displacement of the sealing member that would compromise the uniformity and continuity of the gap between the moving member and the sealing member, the fluid is not allowed to seep between an outer surface of the sealing member and an inner surface of the stationary member. Accordingly, a "fluid-tight relationship" is required between an outer surface of the sealing member and an inner surface of the stationary member (page 5, lines 30-31). The instant specification explains that any sealing method between the sealing member and the stationary member may be used, as long as it provides a reliable seal.

For example, in one embodiment shown in Figure 2, a fluid-tight relationship between the sealing member 25 and the housing structure 21 is accomplished by utilizing a removable elastomeric seal, such as an O-ring 27. The O-ring is positioned in such a way that the fluid cannot pass into and fill the space between the outer surface of the sealing member and the inner surface of the housing. In another embodiment shown in Figure 3, the sealing member 25 is integrally formed with the housing structure 21. In this embodiment, there is no space at all between the outer surface of the sealing member and the inner surface of the housing.

The '655 patent does not anticipate independent claims 1 and 7, because it does not teach a sealing member having a fluid-tight relationship with the stationary member (or housing structure in claim 7) as defined in the present specification. To the contrary, the '655 patent requires filling a gap 18 between the housing and the seal body with fluid to compress the seal body radially inward toward the shaft 4 (column 2, lines 58-65). Also, the '655 patent does not teach a size of the gap between the sealing member and the moving member that prevents the fluid from flowing through the gap. Instead, the '655 patent teaches the size of

the gap that keeps "leakage of high-pressure fluid ... within acceptable limits" (column 3, lines 3-9).

The '655 patent does not make instant claims 1 and 7 obvious because it teaches away from the present invention. The '655 patent teaches that in order to achieve an effective seal under working pressures, the sealing member should have a non-uniform cross-section of the inner wall and form a non-uniform gap with the moving member under low-pressure conditions. The '655 patent relies on deformation of the seal body under high-pressure to produce a uniform gap and to control leakage within predetermined limits (column 3, lines 45-55). The deformation is achieved by filling the gap 18 between the housing and the seal body with the fluid, which radially compresses the seal (column 2, lines 58-65). Furthermore, the '655 patent teaches, "if the gap 14 had an initial uniform width with the high-pressure chamber 7 unpressurized, the gap would not have a uniform width at working pressures..." (column 3, lines 25-33).

Thus, in view of the teachings of the '655 patent, the ability to form a effective seal with the gap that has an initial uniform width that remains uniform under working pressures would not have been expected by those skilled in the art. Also, the '655 patent teaches away from fluid-tight relationship between the sealing member and the stationary member that prevents the fluid from seeping therebetween. Therefore, claims 1 and 7 are neither anticipated nor rendered obvious by the '655 patent. Claims 3 and 5 depend from claim 1 and are all patentable over the '655 patent.

Claims 1, 3-7 and 9-11 are rejected under 35 U.S.C. §102(b) as being anticipated by Breit, U.S. Patent No. 3,902,404 (the '404 patent). This rejection respectfully traversed.

The '404 patent does not anticipate independent claims 1 and 7, because it does not teach the sealing member having a fluid-tight relationship with the stationary member (or housing structure in claim 7) as defined in the present specification. To the contrary, similarly to the '655 patent, the '404 patent teaches filling a control chamber 22 formed between the outer surface of sealing sleeve

and the inner surface of the housing 11 with the fluid to subject the sealing sleeve to radial forces (column 3, lines 46-52; column 4, lines 35-41). The radial forces deform the sealing sleeve, which results in the narrowing of the axial sealing gap 21 between the sealing sleeve and the piston 15 (column 7, lines 34-38).

The '404 patent does not make instant claims 1 and 7 obvious because it teaches away from the present invention. Similarly to the '655 patent, the '404 patent requires radial deformation of the sealing sleeve in order to form an effective seal between the moving piston and the sealing member. The radial deformation is achieved by filling the gap (or "control chamber 22") between the outer surface of the sealing sleeve and the inner surface of the housing with the fluid. Thus, the '404 patent teaches away from the present invention, which requires a fluid-tight relationship between the sealing member and the stationary member that prevents the fluid from seeping therebetween. Accordingly, based on the teachings of the '404 patent, one skilled in the art would not have arrived at instant claims 1 and 7. Therefore, claims 1 and 7 are neither anticipated nor are rendered obvious by the '404 patent. Claims 3-6 and 9-11 depend from claims 1 and 7 and are also patentable over the '404 patent.

Claims 1, 2, 7 and 8 are rejected under 35 U.S.C. §102(b) as being anticipated by Holland, U.S. Patent No. 4,501,120 (the '120 patent). This rejection is respectfully traversed.

The '120 patent does not anticipate claims 1 and 7 because it does not teach "a continuous and uniform gap, having a size that ... prevents the fluid from flowing through the gap." The '120 patent is directed to a refrigeration system circulating a pressurized gas. Unlike the present invention, the '120 patent teaches that "the clearance seal about the piston assures ... leakage [of gas] in each direction past the piston" (column 5, lines 65-68).

The '120 patent does not make instant claims 1 and 7 obvious because it does not constitute analogous art. The subject matter of the '120 patent is not "pertinent to the particular problem with which the inventor was involved." *Startoflex, Inc. v. Aereoquip Corp.*, 713 F. 2d 1530, 1535 (Fed. Cir. 1983). As explained in the

Description of the Prior Art section of the present specification (pages 1-2), the problems facing the inventors were leakage of a fluid, such as a solution, suspension, slurry, etc., around the moving member of the fluid-moving devices and the wear of the fluid seal. The inventors solved these problems by providing a continuous and uniform gap between a sealing member and an outer surface of the moving member, the gap having a size that allows the fluid to fill the gap but prevents the fluid from flowing through the gap.

The '120 patent, on the other hand, is concerned with a gas-filled refrigeration system driven by a pressure differential across a displacer (column 1, lines 13-16). Accordingly, the '120 patent explicitly requires that "... the clearance seal around the piston assures ... leakage [of gas] in each direction past the piston and thus assures a constant pressure in the spring volume" (column 5, lines 65-68). Clearly, not only is the technical problem that the '120 patent is trying to solve different from that of the present invention, but also the teachings of the '120 patent are contrary to those of the present invention. Thus, based on the teachings of the '120 patent, one skilled in the art would not have arrived at the instant claims 1 and 7. Therefore, claims 1 and 7 are neither anticipated nor are rendered obvious by the '120 patent. Claims 2 and 8 depend from claims 1 and 7 and are also patentable over the '120 patent.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6700 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,  
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